REMARKS

Claims 1 through 36 are pending in this case. The present response amends claims 1, 4 through 7, 28, 31, 34, and 36 of the application and deletes claims 2, 3, 8 through 10, 12, and 35. Typographical corrections are made to the Specification and also to comply with the Examiner's objection to Figure 1. Reconsideration and favorable action in the above-referenced application, based on the following remarks, are respectfully requested.

Objection To The Drawings

The Examiner objects to figure 1 because the reference character "14" is used to designate two different items, namely, the channel encoder and the receiver. The Examiner is thanked for his close attention to this detail, and herein Applicants propose a correction to Figure 1 as attached hereto, and shown in the original in red. In the proposed correction, the reference character, to the left of the page, and for the "channel encoder," is proposed to be changed to the number "13." Also consistent with this proposal, the Specification is amended, from page 5, line 10, through page 6, line 10.

Also proposed as an amendment to Figure 1, and shown in the attached proposed revised page, is an inclusion of the legend "B_i" as an input to the channel encoder 13. This legend is consistent with the Specification (*see, e.g.*, page 5, line 10) and was included on the original informal drawings filed with the subject application.

Rejections Under 35 U.S.C. § 103

Claims 1, 8 through 23, 27, 30, and 34 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Harrison U.S. Patent 6,154,485 and further in view of Naguib et al. U.S. Patent 6,178,196 and Lundby et al. U.S. Patent 6,356,528 (hereafter, Harrison, Naguib, and Lundby, respectively). Claim 1 is now amended to include the recitations of what were formerly claims 2, 3, and 8. By way of background to the result of this amendment, note also that claims 2 and 3 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Harrison, Naguib, and Lundby and further in view of Dartois

U.S. Patent 6,181,955, Sabat Jr. et al. U.S. Patent 6,122,529 and Berger et al U.S. Patent 5,259,003.

Applicants respectfully submit that the combined references do not teach the recitation of amended claim 1, and further there is no motivation in the cited art to combine the various (and numerous) references to provide the elements of claim 1. Further and as shown below, the combination as described by the Examiner is not readily workable so as to achieve the combination recited in amended claim 1.

By way of introduction, the Examiner cites Harrison as teaching the application of both open loop diversity and closed loop diversity, where specifically the Examiner cites to column 1, lines 58-67 of Harrison. Applicants respectfully note that the specific text cited by the Examine describes using a system that ***alternates***, or switches between, the open loop diversity of orthogonal transmit diversity ("OTD") and the closed loop diversity of adaptive antenna transmission. Thus, Harrison column 1 suggests an encoder that receives symbols and applies open loop diversity to some of those symbols and closed loop diversity to other of those symbols. In contrast, claim 1 recites that its "encoder circuitry" is "for receiving a plurality of symbols" and that "encoder circuitry is for applying space time block coded transmit antenna diversity and closed loop diversity to ***the*** plurality of symbols to form the signals." Since the claim speaks in terms of "the plurality of symbols," it is respectfully submitted that it is that same plurality of symbols that receives both the open loop and closed loop diversity, rather than sub-dividing that plurality into alternative groups as is suggested by Harrison column 1.

Although not raised by the Examiner, Applicants further invite the Examiner to discuss the remainder of Harrison and, indeed, Applicants call the Examiner's attention, by way of example, to Harrison Figure 5 and the text description thereof. Indeed, at column 8, lines 23 et seq., Harrison describes one approach that results in a "mixed mode" that is, one that "is not strictly an orthogonal transmit diversity mode nor an adaptive array mode. In this mixed mode base transmitter 52 exhibits characteristics of

both modes." Further, even given that such an approach includes some variant that "is not strictly" either open loop (i.e., OTD) or closed loop (i.e., adaptive array), then Applicants respectfully traverse the notion that space time block coded transmit antenna diversity, as recited in claim 1, is an obvious extension of the Harrison "mixed mode." In other words, it is not a case, as possibly suggested by the Examiner, where each of the various types of diversity raised by the Examiner may be merely substituted for one another into Harrison. Indeed, if such an attempt is made as detailed below, then the result does not satisfy the limitations of claim 1.

Looking in greater detail to the "mixed mode" of Harrison, further examination of Harrison Figure 5 is instructive. In that Figure 5, spread traffic signals 72 and 74 are inputs, and they go through various processes with the result producing element signals 94 and 96; these processes are such that the inputs are "combined by adding a portion in one path to the signal in the other path."[1] This combination includes the multiplication and summing as shown in Figure 5. Given that configuration, if "the value of α is equal to 0, and adaptive array weights V_0 and V_1 at multipliers 180 and 182 are equal to 1, adaptive array processor 166 is figured so that base transmitter 52 operates in an orthogonal transmit diversity mode,"[2] that is, in a purely open loop mode. Thus, in this instance, Harrison Figure 5 evidently receives OTD symbol inputs at 72 and 74 and effectively provides those same OTD symbols at its outputs 94 and 96. In contrast, a purely closed loop adaptive array is provided if α is $\frac{1}{\sqrt{2}}$ and V_0 and V_1 are non-zero values.[3] Harrison goes on to then state that to get its "mixed mode" that is "not strictly" either OTD nor adaptive array, then its α must be between 0 and $\frac{1}{\sqrt{2}}$. However, if the Examiner's suggestion of merely substituting STTD into Harrison is applied, then such an approach would provide STTD symbols to Harrison inputs 72 and 74, in which case the STTD nature is destroyed in the resulting signals, that is, there is

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1 Harrison, col. 7, lines 50-51.
2 Harrison, col. 8, lines 4-8.
3 Harrison, col. 8, lines 13-21.

no longer an STTD encoding in the transmitted signals. To further appreciate this, assume that the symbols over two successive time periods to inputs 72 and 74 take the STTD format in the following Table 1:

Input	Time 0	Time 1
72	A	B
74	$-B^*$	A^*

Table 1

For simplification in applying this assumption in Harrison, let $AUX_0=AUX_1=0$ and let $V_0=V_1=1$, then presumably the outputs for these symbols will be as shown in the following Table 2

Output	Time 0	Time 1
94	$A\sqrt{1-\alpha^2}+-B^*\alpha$	$B\sqrt{1-\alpha^2}+A^*\alpha$
96	$-B\sqrt{1-\alpha^2}+A^*\alpha$	$A^*\sqrt{1-\alpha^2}+B^*\alpha$

Table 2

From Table 2, however, one skilled in the art will appreciate that if a value of $\alpha > 0$ is applied as is stated as a requirement by Harrison to achieve its use of both open and closed loop diversity, then the values in Table 2 are each adjusted in such a manner that there is no longer an STTD relationship between the four outputs across the two times. Stated simply, therefore, even if there were a suggestion in the art to merely substitute STTD into Harrison, then the result would not produce an accurate result and nor would it provide the combined recitations of claim 1. Lastly, the additional noted references do not cure this deficiency.

In view of the preceding, Applicants respectfully submit that amended claim 1 is in condition for allowance. Moreover, claims 4 through 7, 11, and 13 through 27 depend from claim 1 and, thus, also are in condition for allowance.

Independent claims 28 and 34 are also amended consistent with the discussion of the above. Further, claim 34 is rejected under the same bases as independent claim 1, and claim 28 is rejected under 35 U.S.C. § 103(a) in view of Harrison. As demonstrated above, Harrison does not demonstrate various aspects now added by amendment into independent claims 28 and 34 and, thus, these claims as well as their respective dependent claims 29 through 33 as depending from claim 28, and 36 as depending from claim 34, are also in condition for allowance.

<u>Fees</u>

The fee for the enclosed petition for an extension of time for a two (2) month extension is addressed in the Fee Transmittal (for FY 2003) sheet filed herewith and is requested to be charged to deposit account number 20-0668 of Texas Instruments Incorporated.

The Commissioner is also hereby requested and authorized to charge any additional fees necessary for the filing of the enclosed papers to deposit account number 20-0668 of Texas Instruments Incorporated.

Respectfully submitted,

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<u>Version with markings to show changes made:</u>

<u>In The Specification</u>

<u>From page 5, line 10, through page 6, line 10</u>

Transmitter 12 receives information bits B_i at an input to a channel encoder <u>13</u> [14]. Channel encoder <u>13</u> [14] encodes the information bits B_i in an effort to improve raw bit error rate. Various encoding techniques may be used by channel encoder <u>13</u> [14] and as applied to bits B_i, with examples including the use of convolutional code, block code, turbo code, or a combination of any of these codes. The encoded output of channel encoder <u>13</u> [14] is coupled to the input of an interleaver 15. Interleaver 15 operates with respect to a block of encoded bits and shuffles the ordering of those bits so that the combination of this operation with the encoding by channel encoder <u>13</u> [14] exploits the time diversity of the information. For example, one shuffling technique that may be performed by interleaver 15 is to receive bits in a matrix fashion such that bits are received into a matrix in a row-by-row fashion, and then those bits are output from the matrix to a symbol mapper 16 in a column-by-column fashion. Symbol mapper 16 then converts its input bits to symbols, designated generally as S_i. The converted symbols S_i may take various forms, such as quadrature phase shift keying ("QPSK") <u>symbols</u> [symbols], binary phase shift keying ("BPSK") symbols, or quadrature amplitude modulation ("QAM") sybmols. In any event, symbols S_i may represent various information such as user data symbols, as well as pilot symbols and control symbols such as transmit power control ("TPC") symbols and rate information ("RI") symbols. Symbols S_i are coupled to a modulator 18. Modulator 18 modulates each data symbol by combining it with, or multiplying it times, a CDMA spreading sequence which can be a pseudo-noise ("PN") digital signal or PN code or other spreading codes (i.e., it utilizes spread spectrum technology). In any event, the spreading sequence facilitates simultaneous transmission of information over a common channel by assigning each of the transmitted signals a unique code during transmission. Further, this unique code makes the simultaneously transmitted signals over the same bandwidth distinguishable at receiver 14 (or other

receivers). Modulator 18 has two outputs, a first output 18_1 connected to a multiplier 20_1 and a second output 18_2 connected to a multiplier 20_2. Each of multipliers 20_1 and 20_2 multiplies its input times a weight value, W_1 and W_2, respectively, and provides an output to a respective transmit antenna $A12_1$ and $A12_2$. By way of example, assume that transmit antennas $A12_1$ and $A12_2$ are approximately three to four meters apart from one another.

<u>From page 10, lines 15 through 17</u>

In view of the above, there arises a need to improve upon the drawbacks of prior art closed loop systems and prior art open loop systems, and such a need is addressed [upon] by the preferred embodiments described below.

<u>From page 13, lines 5 through 24</u>

Figure 3 illustrates a diagram of a cellular communications system 40 by way of a contemporary example in which the preferred embodiments operate. Within system 40 is shown a base station BST, which includes four antennas AT1 through AT4 along which base station BST may transmit (or receive) CDMA or WCDMA signals. In the preferred embodiment, each antenna in the group of antennas AT1 through AT4 is within approximately three to four meters of another antenna in the group. In other embodiments, however, note that the multiple transmit antennas may be much closer to one another; for example, in an environment where base station BST and user station UST are both indoor stations, the distance between the multiple transmit antennas of base station BST may be on the order of inches. Returning to the example of Figure 1, the general area of intended reach of base station BST defines a corresponding CELL and, thus, base station BST is intended to generally communicate with other cellular devices within that CELL. Beyond the CELL there may <u>be</u> other cells, each having its own

corresponding base station, and indeed there may be some overlap between the illustrated CELL and one ore more other cells adjacent the illustrated CELL. Such overlap is likely to support continuous communications should a mobile communication station move from one cell to another. Further in this regard, system 40 also includes a user station UST, which is shown in connection with a vehicle V to demonstrate that user station UST is mobile. By way of example, user station UST includes a single antenna ATU for both transmitting and receiving cellular communications.

<u>From page 24, line 21, through page 26, line 2</u>

As still another example of the present inventive scope, the types of open loop and closed loop transmit diversity also may be changed as applied to the preferred embodiments. Thus, while TxAA has been shown above as a closed loop technique, and STTD has been shown as an open loop technique, one or both of these may be replaced by corresponding alternative techniques and applied to a multiple transmit antenna system, thereby again providing a combined closed loop and open loop transmit antenna system. Indeed, recall above an example is set forth for an inventive system having eight antennas split into sets of four antennas, where open loop transmit diversity is applied within each set of four antennas. In this case, the application of open loop transmit diversity as applied within a set of four antennas will require a type of open loop diversity other than solely the transmission of conjugates; in other words, a use only of conjugates provides two different signals, whereas for four different antennas a corresponding four different signals are required to achieved the open loop diversity. Accordingly, for this as well as other embodiments, a different open loop diversity approach may be implemented. For example, another open loop diversity technique that may be implemented according to the preferred embodiment includes orthogonal transmit diversity ("OTD"), and which is shown for a single OTD encoder 70 in Figure 6 and for BPSK symbols. In Figure 6, OTD encoder 70 is coupled to transmit symbols to four antennas $A70_1$ through $A70_4$. Further, in operation, OTD encoder 70 buffers a number of symbols equal to its number of antennas

(i.e., four in the example of Figure 6), and then each antenna transmits only one corresponding symbol and that is in a form that is orthogonal to all other symbols transmitted along the other antennas. These forms are shown by way of the output symbols in Figure 6 along antennas $A70_1$ through $A70_4$ from time T' through time 4T'. Further, for simplicity Figure 6 only illustrates the OTD operation and, thus, does not further show the use of weighting to achieve the combined closed loop diversity. Nonetheless, the addition of a closed loop weighting operation should be readily implemented by one skilled in the art given the preceding teachings with respect to other embodiments. As another example of an alternative open loop diversity that may be used according to the preferred embodiments, Figure 7 illustrates an STTD encoder 80 for four antennas $A80_1$ through $\underline{A80_4}$ [A80]. The conventions of Figure 7 should be readily appreciated from the preceding examples, where the signals transmitted along antennas $A80_1$ through $\underline{A80_4}$ [A80] therefore represent open loop diverse signals, and for the example where the symbols are BPSK symbols. Also as in the case of Figure 6, for simplicity Figure 7 only illustrates the open loop diversity operation (i.e., STTD) and, thus, Figure 7 does not further show the use of weighting to achieve the combined closed loop diversity, where such additional weighting may be implemented by one skilled in the art according to the teachings of this document. As still another example of an alternative open loop diversity that may be used according to the preferred embodiments, Figure 8 illustrates time switched time diversity ("TSTD") for four antennas. Lastly, other closed loop diversity techniques that may be used to create still further alternative embodiments include switched diversity.

<u>In The Claims</u>

1 (amended). A wireless communication system, comprising:

transmitter circuitry comprising encoder circuitry for receiving a plurality of symbols;

a plurality of antennas coupled to the transmitter circuitry and for transmitting signals from the transmitter circuitry to a receiver, wherein the signals are responsive to the plurality of symbols; and

wherein the encoder circuitry is for applying space time block coded transmit antenna open loop diversity and closed loop diversity to the plurality of symbols to form the signals;

wherein the plurality of antennas comprises a plurality of sets of antennas;

wherein for each of the sets of antennas the encoder circuitry is for applying space time block coded transmit antenna diversity to selected ones of the plurality of symbols such that signals transmitted by any one antenna in the set of antennas represent open loop diversity with respect to signals transmitted by any other antenna in the set of antennas; and

wherein for each of the sets of antennas the encoder circuitry is for applying a weight to the plurality of symbols such that signals transmitted in response to the weight represent a closed loop diversity with respect to signals transmitted by any other antenna in any other of the sets of antennas.

4 (amended). The system of claim 1 [3]:
wherein the plurality of sets of antennas consists of two sets of antennas; and
wherein each of the sets of antennas consists of two antennas.

5 (amended). The system of claim 1 [3]:
wherein the plurality of sets of antennas consists of three sets of antennas; and
wherein each of the sets of antennas consists of two antennas.

6 (amended). The system of claim 1 [3]:
wherein the plurality of sets of antennas consists of two sets of antennas; and
wherein each of the sets of antennas consists of four antennas.

7 (amended). The system of claim 1 [3]:
wherein the plurality of sets of antennas consists of four sets of antennas; and
wherein each of the sets of antennas consists of two antennas.

28 (amended). A wireless communication receiver for receiving signals from transmitter circuitry transmitting along a plurality of sets of transmit antennas, wherein the signals are formed by the transmitter circuitry by applying space time block coded transmit antenna diversity to selected ones of the plurality of symbols such that signals transmitted by any one antenna in the set of antennas represent space time block coded open loop diversity with respect to signals transmitted by any other antenna in the set of antennas and wherein for each of the sets of antennas the encoder circuitry is for applying a weight to the plurality of symbols such that signals transmitted in response to the weight represent a closed loop diversity with respect to signals transmitted by any other antenna in any other of the sets of antennas [open loop diversity and closed loop diversity to a plurality of symbols], the receiver comprising:

a despreader having an output and for producing a despread symbol stream at the output in response to the signals; and

decoder circuitry coupled to the output of the despreader and for decoding space time block coded open loop diversity and closed loop diversity with respect to the despread symbol stream.

31 (amended). The receiver of claim 28 and further comprising:

a channel estimator coupled to the output of the despreader and for determining estimated channel impulse responses based on the despread symbol stream; and

wherein the decoder circuitry is for decoding space time block coded open loop diversity and closed loop diversity with respect to the despread symbol stream and in response to the estimated channel impulse responses.

34. A method of operating a wireless communication system, comprising the steps of:

receiving a plurality of symbols into encoder circuitry;

applying space time block coded open loop diversity and closed loop diversity to the plurality of symbols to form a plurality of signals; and

transmitting the plurality of signals along a plurality of antennas to a receiver;

wherein the plurality of antennas comprises a plurality of sets of antennas; and

wherein the step of applying space time block coded open loop diversity and closed loop diversity applies space time block coded open loop diversity to selected ones of the plurality of symbols such that signals transmitted by any one antenna in the set of antennas represent open loop diversity with respect to signals transmitted by any other antenna in the set of antennas.

36. The method of claim 34 [35] wherein for each of the sets of antennas the step of applying open loop diversity and closed loop diversity applies a weight to the plurality of symbols such that signals transmitted in response to the weight represent a closed loop diversity with respect to signals transmitted by any other antenna in any other of the sets of antennas.